

# **MODIS SCIENCE DATA SUPPORT TEAM PRESENTATION**

**August 30, 1991**

## **AGENDA**

1. Action Items
2. MODIS Airborne Simulator
3. Additional Comments on MODIS Scheduling
4. NETCDF Status

ACTION ITEMS:

05/03/91 [Lloyd Carpenter and Tom Goff]: Prepare a Level-1 processing assumptions, questions and issues list, to be distributed to the Science Team Members and the MCST for comment.

(The list, the executive summary, information on the EOS Platform Ancillary Data, and a cover letter were delivered for signature and distribution.) STATUS: Open. Due date 06/07/91.

06/07/91 [Liam Gumley]: Speak to Alan Strahler, when he returns, regarding his MAS requirements. (Strahler will be contacted when he becomes available.) STATUS: Open. Due date 07/05/91

05/31/91 [Al McKay and Phil Ardanuy]: Examine the effects of MODIS data product granule size on Level-1 processing, reprocessing, archival, distribution, etc. (Reports were provided on June 21 and 28, 1991.) STATUS: Open. Due Date 06/21/91

06/28/91 [Lloyd Carpenter and Tom Goff]: Prepare a detailed list of scheduler assumptions in relation to Level-1 MODIS processing scenarios. (Lists were provided on July 26 and August 16, 1991. Additional comments are included in the handout.) STATUS: Open. Due date 07/26/91.

08/23/91 [Lloyd Carpenter]: Prepare a response to Dr. Charles Gary at Ames providing copies of existing descriptions of MODIS data flow and processing. This information was requested in connection with the Ames study of using optical processors on EOS instrument data. (A response has been prepared.) STATUS: Open. Due Date 09/06/91.

## Progress on MAS Level-1B processing system development

### Progress up to 29 August 1991

An integrated version of the MAS calibration software has been developed. This software performs the following functions.

- (1) Read instrument configuration file.  
The instrument configuration file defines for each MAS channel
  - (a) the spectral band assigned
  - (b) the number of bits per pixel
  - (c) the "bit bucket" channel used (if 10 bit channel)
  - (d) the position of the extra two bits in the bit bucket (if 10 bit channel)
  - (e) whether the channel is visible or thermal infrared
  - (f) the count to radiance calibration slope (if visible channel)
  - (g) the count to radiance calibration intercept (if visible channel).
- (2) Determining whether to use MCIDAS/MAMS or MAS radiance calculation.  
The MCIDAS/MAMS calibration code for the thermal infrared bands uses coefficients generated by Gary Jedlovec at MSFC, and which will be supplied by CIMSS at the University of Wisconsin-Madison. The MCIDAS/MAMS calibration code uses spectral band central wavenumbers and monochromaticity correction factors to compute Planck radiances. The MAS calibration code for the thermal infrared bands computes Planck radiances directly from pre-defined MAS spectral responses. The user may select either method.
- (3) Generating temperature to radiance conversion for MAS radiance calculation.  
If MAS calibration is selected, then the user can select to compute a temperature to radiance conversion table, which is used later for computing interpolated radiances. Planck radiances are optionally computed for all bands designated as thermal IR in the configuration file. The temperature range used is 150K to 350K in steps of 1K.
- (4) Generating radiance interpolation polynomials for MAS radiance calculation.  
If MAS calibration is selected, then cubic spline interpolation polynomials are generated from the temperature to radiance conversion tables for all bands designated as thermal IR. This allows computation of the Planck radiance for any thermal IR band at any temperature between 150K and 350K.
- (5) Accessing input MAS Level-1A data file and output calibration data file.  
The input Level-1A MAS data file and the output calibration data file are both opened. The calibration data file has space for slopes and intercepts for all 12 channels. Values are stored as FORTRAN 32 bit real numbers.
- (6) Checking the quality of the blackbody counts and temperatures in ALL channels.  
In order to check the quality of the data in any given scan line, the black body counts and temperatures are examined for validity. These are both 16 bit signed integers in the Level-1A dataset. The counts are checked to ensure they lie within the range defined by the number of bits per pixel (8 bits = 0-255, 10 bits = 0-1023). The temperatures are checked to ensure they lie within the range 0K to 373K. These values are checked for ALL channels present. A bad data flag is set if necessary.

- (7) Computing radiances from the black body temperatures.  
The Planck radiances corresponding to the hot and cold black body temperatures are calculated depending on the method (either MCIDAS/MAMS or MAS) selected by the user.
- (8) Computing the calibration slope and intercept for all channels.  
The count value for the hot black body is first checked to ensure it is greater than the count value for the cold black body. If this is not the case, the bad data flag is set. Then given the count values, and the corresponding radiances, the slope and intercept for count to radiance conversion is computed for the thermal IR channels. For visible channels, the values defined in the instrument configuration file are retrieved. If the bad data flag is set for any reason, then the slopes and intercepts for all channels are set to zero.
- (9) Writing the calibration slopes and intercept data to the output calibration file.  
The slopes and intercepts for all 12 channels for every scan line are written to the output calibration data file.

FLIGHT 90-072 DATE 04/15/90 A/C 709 TAKEOFF 13:00/15 LAND 18:30/15

RECORDER UNIT NUMBER 2

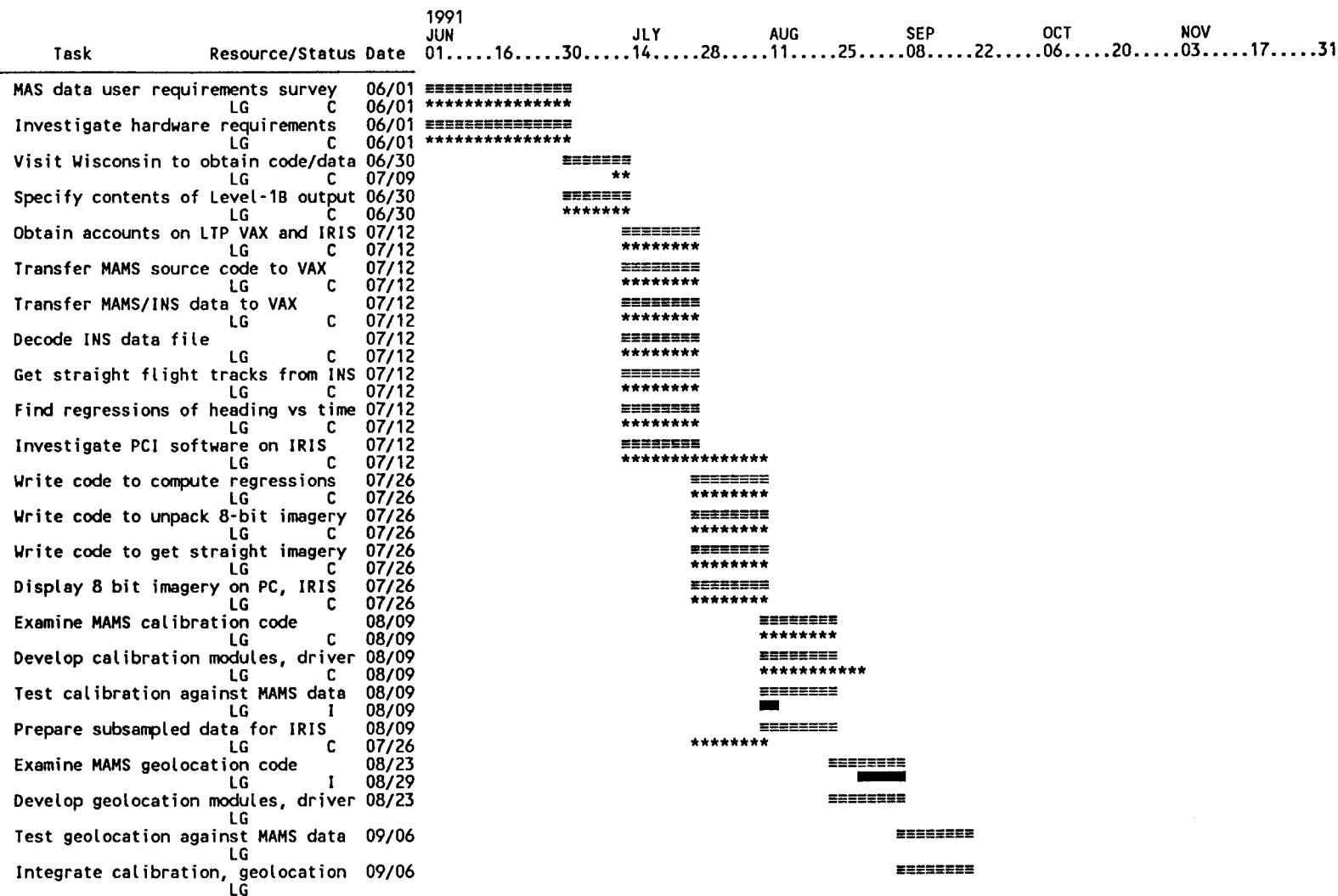
( GMT )	T	I	LATITUDE	LONGITUDE	ALTITUDE	AIR	PITCH	ROLL	TRUE	N-S	E-W	VERT	GRND	COMPUTED	W I N D	VERT	COMPUTED	TEMPERATURE	
TIME DAY	M		DEG MIN	DEG MIN	FEET	SPD	DEG	DEG	HEADG	VEL	VEL	VEL	SPD	GROUND	SPEED	ANGLE	VEL	ANGLE OF	DEGREE C
HH:MM:SS/DD	E					KNOT			DEG	KNOT	KNOT	FPS	KNOT	KNOT	KNOT	DEG	FPS	ATTACK	
13:00:55/15	G		N28:12.8	W080:37.3	371	146	17.2	5.7	23.4	122	54		142	142	13	163		18	-48.8
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13:03:25/15	G		N28:13.4	W080:30.4	12945	186	14.0	20.2	218.7	-146	-80		166	166	37	269	78	14	-58.7
13:03:30/15	G		N28:13.1	W080:30.7	13345	186	12.0	19.9	229.8	-126	-108		167	167	35	259	80	15	-58.9
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13:03:55/15	G		N28:12.8	W080:31.7	15111	218	10.3	-11.0	272.0	13	-184		185	185	34	278	79	12	-59.6
13:04:00/15	G		N28:12.8	W080:32.0	15476	216	12.3	-4.7	269.0	12	-185		186	186	35	296	73	12	-60.0
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13:04:35/15	G		N28:12.8	W080:34.0	18448	193	15.6	9.0	271.3	15	-169		163	163	26	293	92	16	-62.0

Date: 08/29/91  
Each Symbol = 2 Days

MAS Level-1B Processing System  
MAS01

≡ Planned  
■ Actual  
\* Completed  
M Milestone

MAS Level-1B Processing System Development at GSFC

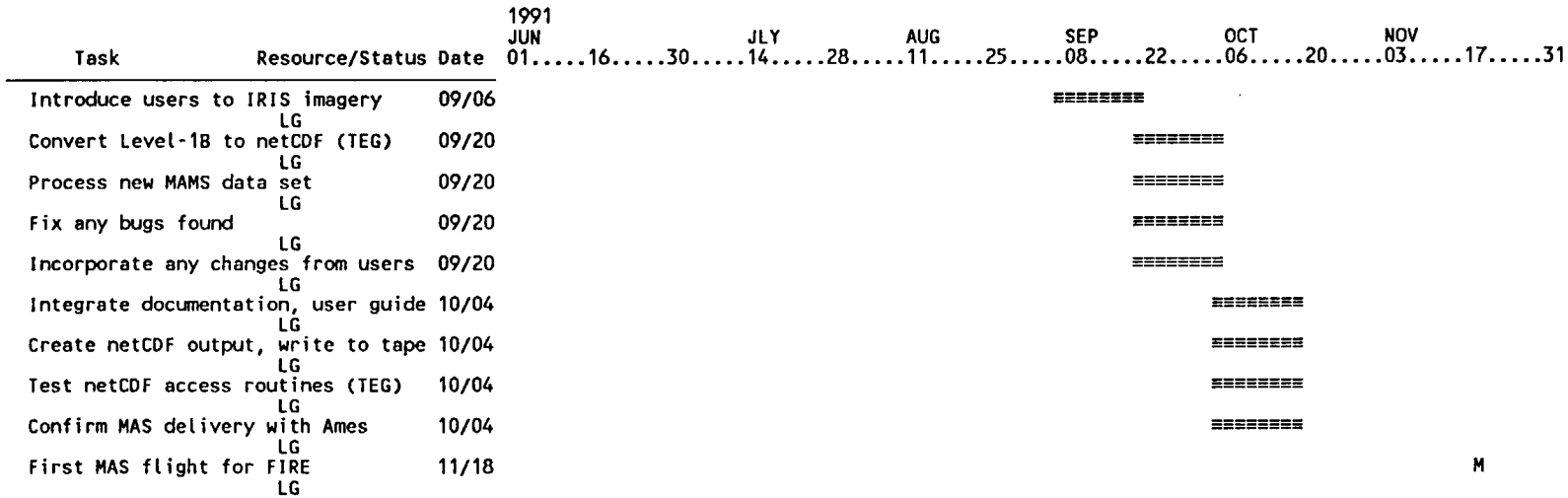


Date: 08/29/91  
Each Symbol = 2 Days

MAS Level-1B Processing System  
MAS01

≡ Planned  
■ Actual  
\* Completed  
M Milestone

MAS Level-1B Processing System Development at GSFC



## **Additional Comments on MODIS Scheduling**

Thomas E. Goff

DRAFT

**The normal creation of a process.** Spacecraft data is acquired at a fixed rate at a predetermined time. When an instrument is enabled and taking data, the amount of data the instrument produces per unit time can be determined apriori. The MODIS instruments will record and transfer data via TDRSS on an orbital basis. This leads to a bursting of data packets to CDOS and eventually onto the Level-1A MODIS process (program). The Level-1A process creates a Level-1A data product quantum (see Glossary) which can be conveniently organized on an orbital basis. For computer scheduling purposes, a MODIS Level-1A process can then be spawned (created but not executed) for each orbital pass.

For each process in the chain of MODIS processing, the spawning of a process must take place at predetermined times, based upon the generation of data at the instrument. Each process in the MODIS processing chain may be spawned as the input data sets are generated.

**Time criticalness of execution.** After a process is spawned, the computer operating system executes the process based on available resources and priorities. Normally, these are computer operating system functions that are not under the control of user processes. However, the MODIS data products have a requirement that data be produced either immediately (quick look) or within 24 hours (for example) from the execution of the previous process in the MODIS chain of events. This can be accommodated by allowing a "watch dog" scheduling process to increase the priority of MODIS processes after they have been spawned onto the operating system. This is similar to a priority aging technique as used by computer operating systems.

**Data set completeness.** Due to the time criticalness of producing a data product, a product (data set) may be produced before all the required input data is available. This case is handled by producing a "dummy" product that is the correct size (a data product size is known apriori) but contains a data value (flag) that indicates invalid or missing data. The real data is then inserted into the output data product as it is generated. In addition, an input product map within the output data product indicates the completeness of that product by placing a tag (data packet time tag, input data product name, or other qualifier) that can be used to indicate not just the presence of invalid or missing data, but also a measure of the completeness of the output product.

**Data Product Pointers.** Complete forward and backwards pointers are to be maintained for all data products. This allows a supervisory process to examine a data set for completeness and to know which process to initiate when missing data is subsequently obtained. The decision to initiate a process when previous data products have been updated is not automatic, but can be based upon a completeness quality indicator (see below) or other method.



**rocessing of incomplete data sets.** The programs in the MODIS chain of processing events require a dependency table with entries containing the data products required before each MODIS processor is executed. For example, the Level-1A processor needs the MODIS telemetry packets and the S/C ancillary data packets from CDOS that apply to a proposed execution of this processor, the Level-2 product requires the creation of the corresponding Level-1A product in addition to atmospheric data, etc. In addition to the product specifiers, this dependency table will contain a measure of the quality (completeness) of the input data sets. This allows a MODIS scheduler to perform a conditional spawning of a process based upon the time criticalness of producing the output data product and the completeness of the input data sets. As an example implementation, the completeness could be represented by a real number between 0.0 and 1.0. A value of 1.0 would represent a complete perfect (quality assured) input data set. Multiplying all the input data set completeness indicators would then yield a measure of the total input data quality. This value could then be factored into a priority value which increases as the 24 time limit approaches to give a final processing priority.

**Quality control inheritance.** The above mentioned completeness indications are based upon the inheritance of the quality control measures of previous data products. As each output product is finalized, the input quality indicators are combined with other internally derived quality assurance measures to produce an output quality completeness indication. This value is placed into the dependency table for use by other processors in the processing chain.

**Summary.** It is recommended that a scheduler algorithm appropriate to the MODIS processing chain be implemented. This algorithm should utilize a dependency table containing a "fuzzy" completeness indication to determine when a follow-on process should be initiated. Algorithms to generate this completion indication and the resulting execution priority can be invented based upon further examination of the MODIS processing criteria.

## Glossary

**Quantum of data:** A data set that is organized as a complete entity (or object) and is addressable with a unique tag (file name). def: "1. Quantity or amount: the least quantum of evidence. 2. a particular amount. 3. a share or portion."

**Data Granule:** The smallest addressable part of a data set (product) that can be handled within a process (computer program). def: "1. a little grain. 2. a small particle: pellet."

**Process Spawning:** The creation of a computer program with it's associated input and output data set specified. One computer program can be spawned several times with differing data sets. def: "To produce in great numbers."

**Pointers:** A database term that, for any given data set, points to the input data used to generate that data set (backward pointers) and the specifier of the data set to which that data set will be used (forward pointers). The forwards pointers may be generated after the current data set has been produced or archived.